FORM PTO-1390 (REV. 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER: GER5355

U.S. APPLICATION NO (If known, see 37 CFR 1 5): 09/980169

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT / GB00/01727	05 May 2000	05 June 1999

TITLE OF INVENTION: LIFT-AND-STRIKE WELDING PROCESS WITH CLEANING STAGE

APPLICANT(S) FOR DO/EO/US: KRENGEL et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ■ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ■ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ■ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ■ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (unsigned)
10. ☐ An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ■ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☐ Other items or information:

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/980169	PCT/GB00/01727	GER5355

21. ■ The following fees are submitted:

	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total claims	23 - 20 =	3	x **$18.00**	$ 52.00	
Independent claims	2 - 3 =	0	x **$84.00**	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$ 942.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+	$	
SUBTOTAL =				$ 942.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
TOTAL NATIONAL FEE =				$ 942.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 942.00	
				Amount to be refunded:	$
				charged:	$ 942.00

a. ☐ A check in the amount of $ _____ to cover the above fees is enclosed.

b. ■ Please charge my Deposit Account No. 02-2550 in the amount of $ 942.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ■ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-2550. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Edward D. Murphy
The Black & Decker Corp.
701 E. Joppa Rd.
Towson MD 21286
(410) 716-2867 (tele)

SIGNATURE

Edward D. Murphy
NAME

20,625
REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:	**KRENGEL et al.**		
Serial No.:	Not Yet Assigned		
Filed:		Art Unit:	
For:	**LIFT-AND-STRIKE WELDING PROCESS WITH CLEANING STAGE**	Docket No.:	**GER5355**

"Express Mail" mailing label number ET527175579US ; Date of Deposit: 11-29-2001
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and is addressed to the **U.S. Patent and Trademark Office, P.O. Box 2327, Arlington, VA 22202.**

SHARON GILDEN
(Printed name of person mailing paper or fee)

Sharon Gilden
(Signature of person mailing paper or fee)

PRELIMINARY AMENDMENT

The Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Prior to examination of the accompanying application, please make the following amendments:

IN THE SPECIFICATION:

Please amend the text beginning on line 14 of page 1, as follows:

"[~~From DE 195 244 90, for example, a~~] In the prior art, the lift-and strike welding process is known, wherein an aluminum weld stud is welded to a workpiece made of aluminum. [~~According to said~~] In such a process, [a] the height of lift of the weld stud [~~is varied~~] will vary [~~in dependence~~] depending upon [a] the measured arc voltage. It is also known [~~from said document that,~~] in the prior art to prevent a short circuit from being caused by melted material dripping from the weld stud, by reversing the polarity at either the weld stud or [~~at~~] the workpiece [~~is reversed~~] during the welding operation.

It is also known that, by reversing the polarity, [~~a~~] the formation of [~~a~~] the molten bath [~~is~~] may be varied."

Please delete the last paragraph of page 1 (beginning on line 27 and continuing on lines 1 and 2 of page 2) in its entirety.

Please amend the sentence beginning on line 4 of page 2, as follows:

"[~~A first~~] The lift-and-strike welding process is such that, as a first step, a surface of a component is cleaned, namely by applying a first voltage so as to strike an arc between [~~an element~~] a stud to be connected to the surface[~~, in particular a stud,~~] and the surface."

Please amend the sentence beginning on line 10 of page 2, as follows:

"[Said] This process is particularly suitable for use with both steel sheets and aluminum sheets, which have either an organic coating or [~~are~~] zinc-coated."

Please amend the sentence beginning on line 19 of page 2, as follows:

"The features described below are however also applicable to the welding of a corresponding steel [~~component, in particular a steel~~] sheet."

Please amend the sentence beginning on line 27 of page 2, as follows:

"By striking [~~an~~] a cleaning arc [~~as a cleaning arc~~], the effect is achieved that the organically based coating as a result of overheating by the arc volatilises leaving no significant residues, in particular leaving no residue, and/or is displaced from the welding region."

Please amend the third paragraph of page 7, beginning on line 21, as follows:

"[~~Besides the previously described features, the measures~~] It is known in the prior art to use devices for controlling and/or regulating [~~the weld stud which are known from DE 195 244 90 are moreover also applicable for effecting~~] both the steel sheet and the aluminum lift-and-strike welding process. In particular, it has proved advantageous to use, for welding-on, stud geometrics of the [~~type disclosed in DE 196 11 711~~] various types known in the prior art. [~~Express reference is hereby made to the respective technical teaching of both documents.~~]"

Please amend the first sentence of the last paragraph of page 7, beginning on line 28, as follows:

"An aluminum lift-and-strike welding apparatus is further provided in the present invention."

Please amend the description of the drawings, beginning on page 8, line 21, and continuing through line 4 of page 9, as follows:

"Fig. 1 shows a characteristic of a distance S and of an electric cleaning current I in a first step of the lift-and-strike welding process of the present invention;

Fig. 2 shows the characteristic of the distance S and of the electric current I in a welding step as a third step of the process of the present invention;

Fig. 3 shows a development in the form of a combination of the first step, a second step and the third step of the present invention;

Fig. 4 shows an embodiment of an apparatus for implementing the process of the present invention;

Fig. 5 shows a sketch of a diagramatic embodiment of an [~~the~~] apparatus for implementing the process of the present invention;

Fig. 6 shows a circuit diagram of a polarity reversing means of the present invention; and

Fig. 7 shows a stud welded on a sheet having a coating."

Please amend the sentence beginning on line 14 of page 10, as follows:

"Reversal of the polarity from positive to negative in the second step is followed by the start of a lift-and-strike welding process [~~of the type disclosed e.g. also by the already cited DE 195 244 90~~].

Please add the following paragraph at the end of page 13, beginning on line 20:

"In general, the above identified embodiments are not to be construed as limiting the breadth of the present invention. It will be understood that modifications or other altnerative constructions may become apparent within the scope of the invention as defined in the appended claims."

IN THE CLAIMS:

Please amend each of the following claims as indicated below:

1. A [~~First~~] lift-and-strike welding process, [~~wherein in a~~] comprising the first step of:

a. cleaning a surface (5) of a component [~~is cleaned~~] by applying a first voltage so as to strike an arc between [~~an element~~] a stud (4), [~~in particular a stud,~~] which is to be connected to the surface (5), and the surface (5)[~~,~~]; and

b. [~~in a second step a~~] reversing the polarity of the first voltage [~~is reversed and~~] wherein the [~~element~~] stud (4) is [~~then~~] welded [~~on~~] to the surface (5) by means of at least one arc struck by means of a second voltage.

2. [~~Lift-and-strike welding process according to claim 1, wherein~~] The process claimed in Claim 1 wherein:

a. setting the first voltage [~~is set, in terms of its magnitude,~~] higher than a subsequent second voltage of reverse polarity.

3. [~~Lift-and-strike welding process according to claim 1 or 2,~~] The process claimed in Claim 2 wherein:

a. adjusting the first voltage [~~is adjusted with~~] to a positive polarity.

4. [~~Lift-and-strike welding process according to one of claims 1 to 3,~~] The process claimed in Claim 3 wherein:

a. [~~the element is welded onto the component after the component has previously been covered with a coating, in particular~~] coating the stud (4) with a lubricant layer for a cold-forming machining operation[~~, preferably a deep-drawing machining operation~~] prior to welding the stud (4) onto the surface (5).

5. [~~Lift-and-strike welding process according to one of claims 1 to 4,~~] The process claimed in Claim 4 wherein:

a. [~~after a drop of the first voltage a polarity of~~] reducing the first voltage to [~~changes in~~] a zero-current state[~~,~~];

b. using a pilot voltage of a different polarity at the start of the [a] welding process; and

c. [~~using preferably a pilot voltage and~~] subsequently raising the [~~welding~~] voltage [~~then ensues, wherein both voltages have a different polarity to the first voltage~~] to a welding voltage thereafter.

6. [~~Lift-and-strike welding process according to one of claims 1 to 5,~~] The process claimed in Claim 5 wherein:

a. [~~upon attainment of a passage through zero of the first voltage a~~] maintaining the zero voltage [~~is maintained~~] for a predetermined period of time, [~~after which~~] a second voltage is [~~built~~] building up and applying the second welding voltage.

7. [~~Second lift-and-strike welding process, in particular according to one of claims 1 to 6,~~] The process claimed in Claim 6 wherein:

a. an electric cleaning current flows between a surface (5) of [~~a~~] the component and [~~an element to be~~] the stud (4) welded thereon[~~,~~] with the stud (4) resting [~~in that the component rests~~] on the surface (5)[~~;~~] [~~and then the element~~] lifting the stud (4) [~~is lifted~~] off the surface (5) up to an approximately[~~, in terms of time,~~] constant distance for removing a coating from the surface (5) through ignition of an arc as a cleaning agent[~~,~~];

b. changing the polarity of [~~then~~] the current [~~changes its polarity~~], wherein afterwards at least one welding current is produced; and

c. [~~then the element~~] welding the stud (4) [~~is welded~~] to the surface (5).

8. [~~Lift-and-strike welding process according to one of claims 1 to 7,~~] The process claimed in Claim 7 wherein:

a. using a [~~the~~] cleaning current [~~assumes a current intensity~~] of between 15 amperes and 500 amperes [~~before it drops.~~]; and

b. reducing the cleaning current after the cleaning operation.

9. [~~Lift-and-strike welding process according to claim 7 or 8,~~] The process claimed in Claim 8 wherein:

a. [~~after a reversal of the polarity an, in terms of magnitude,~~] reversing the polarity of the current; and

b. applying a maximum welding current [~~is produced~~] to weld the stud (4) to the surface (5).

10. [~~Lift-and-strike welding process according to one of claims 1 to 9,~~] The process claimed in Claim 9 wherein:

a. moving the stud (4) [~~the element (4) is brought back~~] into contact with the surface (5) [~~only~~] after disconnection of the welding current.

11. [~~Lift-and-strike welding process according to one of claims 1 to 10,~~] The process claimed in Claim 10 wherein:

a. applying the cleaning current [~~lasts~~] as long as or longer than [~~a~~] the pilot current, which [~~flows~~] is applied prior to applying the welding current [~~and/or the welding current~~].

12. [~~Lift-and-strike welding process according to one of claims 1 to 11,~~] The process claimed in Claim 11 wherein:

a. applying a [~~the~~] welding current that is equal to or stronger than the cleaning current.

13. [~~Lift-and-strike welding process according to one of claims 1 to 12,~~] The process claimed in Claim 12 wherein: [~~the element (4) during cleaning of the surface (5) assumes a distance (S) from the surface (5) which is at least two times greater than the distance (S) from the surface (5) during welding, in particular when a pilot current flows prior to the welding current.~~]

a. raising the stud (4) to a predetermined distance (S) for cleaning which is at least two times greater than the distance (S) for welding that the stud (4) is raised above the surface (5).

14. [~~Lift-and-strike welding process according to one of claims 1 to 13,~~] The process claimed in Claim 13 wherein: [~~through the measurement of a parameter a duration of the cleaning step is regulated or controlled.~~]

a. controlling the time period of the cleaning process by measuring the current at the surface (5).

15. A Lift-and-strike welding apparatus (1) having a guide (9) for a weld-on [~~element~~] stud (4) and a control device (10) [~~or regulator~~] for the guide (9) [~~as well as~~] and a programmed device (11) for controlling or regulating the electric current and[~~/or~~] the voltage used for welding, [~~wherein~~] the lift-and-strike welding apparatus (1) [~~comprises~~] comprising:

a. a polarity reversing means (12) for the voltage used for welding[~~, characterised in that~~] included in the programmed device (11) [~~for controlling or regulating the electric current and/or the voltage used for welding is programmed or operated in such a way as to produce, prior to the welding operation,~~] to provide a cleaning current which has a reverse polarity compared to the welding current that is produced prior to the welding operation.

[~~16. Lift-and-strike welding apparatus (1) according to claim 15, characterised in that said apparatus is designed for implementing a process according to claims 1 to 14.~~]

[~~17~~]16.[~~Lift-and-strike welding apparatus (1) according to one of claims 5 or 16, characterised in that said apparatus comprises~~] The combination claimed in Claim 15 wherein:

a. the programmed device (11) has a focusing device [~~for~~] to produce an arc which is to be struck.

[~~18~~]17.[~~Lift-and-strike welding apparatus (1) according to one of claims 15 to 17, characterised in that the~~] The combination claimed in Claim 16 wherein:

a. the programmed device (11) has a polarity reversing means (12) [~~comprises~~] to produce a shorted circuit for maintaining [~~a~~] the struck arc during a reversal of the polarity.

[~~19~~]18.[~~Lift-and-strike welding apparatus (1) according to one of claims 15 to 18, characterised in that said apparatus comprises~~] The combination claimed in Claim 17 wherein:

a. the welding apparatus (1) has an evaluation device[~~, particularly for quality inspection, for at least one parameter at least of~~] that operates during the cleaning operation to inspect the quality of the cleaning.

[~~20~~]19.[~~Polarity reversing means (12) for a lift-and-strike welding apparatus in particular according to one of claims 15 to 19, characterised in that~~] The combination claimed in Claim 18 wherein:

a. the polarity reversing means (12) [~~comprises~~] has a circuit element[~~,~~];

b. [~~which~~] the circuit element produces an arc current [~~in order to~~] maintains [~~a~~] the struck arc during [a] the reversal of a polarity of the arc voltage.

[~~21~~]20.[~~Polarity reversing means (12) according to claim 20, characterised in that~~] The combination claimed in Claim 19 wherein:

a. [~~the polarity reversing means (12) comprises~~] a first (13) [~~and a second (14)~~] power source[~~,~~] formed in the polarity reversing means (12) wherein the first power source (13) [~~supplies~~] to supply a cleaning current to the welding apparatus (1); and

b. [~~the~~] a second power source (14) formed in the polarity reversing means (12) [~~supplies~~] to supply a pilot current and[~~/or~~] a welding current to the welding apparatus (1).

[~~22~~]21.[~~Polarity reversing means (12) according to claim 20 or 21, characterised in that~~] The combination claimed in Claim 20 wherein:

a. a coil (15) is connected to the second power source (14) [~~in such a way that a~~] to maintain the struck arc [~~continues to be maintained~~] during [~~a~~] the reversal of the polarity.

[~~23~~]22.[~~Aluminum surface with welded-on element (4), wherein the aluminum~~] The combination claimed in Claim 15 wherein:

a. the surface (5) is formed of aluminum;

b. the surface (5) has [~~or has had~~] a lubricant coating (8)[~~, in particular a lubricant layer,~~] formed thereon during its manufacture[~~d using a process according to one of claims 1 to 14~~].

[~~24~~]23.[~~Steel sheet with welded-on element, wherein the steel sheet surface has or has had a coating, in particular a lubricant layer or a zinc layer, manufactured using a process according to claims 1 to 14.~~] The combination claimed in Claim 15 wherein:

a. the surface (5) is formed of steel sheet; and

b. the surface (5) has a lubricant coating formed thereon during its manufacture.

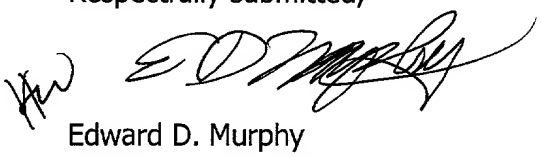
REMARKS

The Applicant's Attorney has amended the specification and the claims to place the case in keeping with the United States patent practice. For convenience, **a clean version of the amended claims is attached hereto as Attachment I.**

The Commissioner is authorized to charge payment of any fees due in processing this Amendment or credit any overpayment to Deposit Account No. 02-2550. One additional copy of this paper is attached.

If the Examiner wishes to discuss any aspects of this application, the Examiner should call the undersigned attorney who represents the applicant.

Respectfully submitted,



Edward D. Murphy
Attorney for Applicant
Reg. No. 20,625

Date: November 29, 2001

The Black & Decker Corporation
701 East Joppa Road, TW199
Towson, Maryland 21286
Phone: (410) 716-2867
Fax: (410) 716-2610

JC10 Rec'd PCT/PTO 29 NOV 2001

ATTACHMENT I
To Preliminary Amendment

Amended Claims

1. [amended] A lift-and-strike welding process comprising the first step of:

   a. cleaning a surface (5) of a component by applying a first voltage so as to strike an arc between a stud (4), which is to be connected to the surface (5), and the surface (5); and

   b. reversing the polarity of the first voltage wherein the stud (4) is welded to the surface (5) by means of at least one arc struck by means of a second voltage.

2. [amended] The process claimed in Claim 1 wherein:

   a. setting the first voltage higher than a subsequent second voltage of reverse polarity.

3. [amended] The process claimed in Claim 2 wherein:

   a. adjusting the first voltage to a positive polarity.

4. [amended] The process claimed in Claim 3 wherein:

   a. coating the stud (4) with a lubricant layer for a cold-forming machining operation prior to welding the stud (4) onto the surface (5).

5. [amended] The process claimed in Claim 4 wherein:

a. reducing the first voltage to a zero-current state;

b. using a pilot voltage of a different polarity at the start of the welding process; and

c. subsequently raising the voltage to a welding voltage thereafter.

6. [amended] The process claimed in Claim 5 wherein:

a. maintaining the zero voltage for a predetermined period of time, a second voltage is building up and applying the second welding voltage.

7. [amended] The process claimed in Claim 6 wherein:

a. an electric cleaning current flows between a surface (5) of the component and the stud (4) welded thereon with the stud (4) resting on the surface (5) lifting the stud (4) off the surface (5) up to an approximately constant distance for removing a coating from the surface (5) through ignition of an arc as a cleaning agent;

b. changing the polarity of the current wherein, afterwards, at least one welding current is produced; and

c. welding the stud (4) to the surface (5).

8. [amended] The process claimed in Claim 7 wherein:

a. using a cleaning current of between 15 amperes and 500 amperes; and

b. reducing the cleaning current after the cleaning operation.

9. [amended] The process claimed in Claim 8 wherein:

a. reversing the polarity of the current; and

b. applying a maximum welding current to weld the stud (4) to the surface (5).

10. [amended] The process claimed in Claim 9 wherein:

a. moving the stud (4) into contact with the surface (5) after disconnection of the welding current.

11. [amended] The process claimed in Claim 10 wherein:

a. applying the cleaning current as long as or longer than the pilot current, which is applied prior to applying the welding current.

12. [amended] The process claimed in Claim 11 wherein:

a. applying a welding current that is equal to or stronger than the cleaning current.

13. [amended] The process claimed in Claim 12 wherein:

a. raising the stud (4) to a predetermined distance (S) for cleaning which is at least two times greater than the distance (S) for welding that the stud (4) is raised above the surface (5).

14. [amended] The process claimed in Claim 13 wherein:

a. controlling the time period of the cleaning process by measuring the current at the surface (5).

15. [amended] A Lift-and-strike welding apparatus (1) having a guide (9) for a weld-on stud (4) and a control device (10) for the guide (9) and a programmed device (11) for controlling or regulating the electric current and the voltage used for welding, the lift-and-strike welding apparatus (1) comprising:

a. a polarity reversing means (12) for the voltage used for welding included in the programmed device (11) to provide a cleaning current which has a reverse polarity compared to the welding current that is produced prior to the welding operation.

16. [amended] The combination claimed in Claim 15 wherein:

a. the programmed device (11) has a focusing device to produce an arc which is to be struck.

17. [amended] The combination claimed in Claim 16 wherein:

a. the programmed device (11) has a polarity reversing means (12) to produce a shorted circuit for maintaining [~~a~~] the struck arc during a reversal of the polarity.

18. [amended] The combination claimed in Claim 17 wherein:

a. the welding apparatus (1) has an evaluation device that operates during the cleaning operation to inspect the quality of the cleaning.

19. [amended] The combination claimed in Claim 18 wherein:

a. the polarity reversing means (12) has a circuit element;

b. the circuit element produces an arc current maintains the struck arc during the reversal of a polarity of the arc voltage.

20. [amended] The combination claimed in Claim 19 wherein:

a. a first (13) power source formed in the polarity reversing means (12) wherein the first power source (13) to supply a cleaning current to the welding apparatus (1); and

b. a second power source (14) formed in the polarity reversing means (12) to supply a pilot current and a welding current to the welding apparatus (1).

21. [amended] The combination claimed in Claim 20 wherein:

a. a coil (15) is connected to the second power source (14) to maintain the struck arc during the reversal of the polarity.

22. [amended] The combination claimed in Claim 15 wherein:

a. the surface (5) is formed of aluminum;

b. the surface (5) has a lubricant coating (8) formed thereon during its manufacture.

23. [amended] The combination claimed in Claim 15 wherein:

a. the surface (5) is formed of steel sheet; and

b. the surface (5) has a lubricant coating formed thereon during its manufacture.

LIFT-AND-STRIKE WELDING PROCESS WITH CLEANING STAGE

The invention relates to a lift-and-strike welding process as well as to a lift-and-strike welding apparatus. The process and the apparatus are suitable in particular for welding a weld stud onto an aluminium surface or steel sheet surface, which have in each case a surface coating, e.g. a lubricant coating.

A lift-and-strike welding process, in particular a stud lift-and-strike welding process, has the advantage of industrial-scale capability combined with processing reliability with regard to, for example, reliable ignition of an arc. The lift-and-strike welding process is also less noisy than other welding processes. The lift-and-strike welding process is therefore used in numerous fields especially on account of its being economical to operate. Especially in the automobile industry, lift-and-strike welding has become an established technique. Aluminium and aluminium composite components are becoming increasingly popular as materials in the automobile industry on account of their low weight. From DE 195 244 90, for example, a lift-and-strike welding process is known, wherein an aluminium weld stud is welded to a workpiece made of aluminium. According to said process, a height of lift of the weld stud is varied in dependence upon a measured arc voltage. It is also known from said document that, to prevent a short circuit being caused by melted material dripping from the weld stud, a polarity at the weld stud or at the workpiece is reversed during the welding operation. It is also known that, by reversing the polarity, a formation of a molten bath is varied.

The object of the present invention is therefore to provide a lift-and-strike welding process and a corresponding lift-and-strike welding apparatus, with which an element may be welded reliably and with a high quality onto a surface, even if a coating should be disposed on the surface.

Said object is achieved by a first lift-and-strike welding process having the features of claim 1 as well as by a second lift-and-strike welding process having the features of claim 7, by a lift-and-strike welding apparatus having the features of claim 15 as well as

by means of a polarity reversing means having the features of claim 20. Advantageous developments and refinements are indicated in the dependent claims.

A first lift-and-strike welding process is such that, as a first step, a surface of a component is cleaned, namely by applying a first voltage so as to strike an arc between an element to be connected to the surface, in particular a stud, and the surface. In a second step, a polarity of the first voltage is reversed. Then the element is welded on by means of at least one second voltage.

Said process is particularly suitable for use with steel sheets and aluminium sheets, which have an organic coating or are zinc-coated. The zinc coating may be electro-plated or galvanised or may be Bonazink. The coating may also consist of accumulated dirt or the like. For example, it has proved particularly suitable to use the process for the welding of steel sheets having a sheet thickness of 1 to 0.5 mm and less which has a zinc protection layer, e.g. in the case of hot galvanising, of 70 µm and less, e.g. also in the case of thin zinc protection layers, of 30 to 3 µm or even less. The cleaning process is very precisely adaptable to the surface to be cleaned and is also suitable for very thin coatings. There now follows a detailed description of the mode of operation of the invention with reference to a machining of a component made of aluminium. The features described below are however also applicable to the welding of a corresponding steel component, in particular a steel sheet.

Aluminium components which are cold formed, in particular deep drawn, have a surface coating in the form of a lubricant. Said lubricant prevents cold welding between the aluminium workpiece and a machining tool. The lubricant moreover reduces the friction force which arises. An organic coating, in particular a wax or oil-based coating is often used. By striking an arc as a cleaning arc, the effect is achieved that the organically based coating as a result of overheating by the arc volatilises leaving no significant residues, in particular leaving no residue, and/or is displaced from the welding region. The subsequent actual welding operation by means of e.g. a pilot current and subsequent welding current of the lift-and-strike welding process allows the element, which is to be

welded on, to be dipped into a weld pool of the aluminium surface which is not contaminated with the previous coating.

For cold-formed aluminium sheets a wax-based lubricant coating is customary. During an arc welding process, the wax releases hydrogen which would bond with the molten aluminium during the welding operation. The moment the molten aluminium hardens again, the ability of the aluminium to bond with the released hydrogen is lost. The hydrogen is exhaled and leaves behind a high porosity in the region of the joint zone. Said porosity leads to an enormous deterioration of the welding quality. Through use of the aluminium lift-and-strike welding process it is possible to avoid a poor welding quality. The process also allows its users to dispense with previous cleaning of the aluminium components used. Cold deep-drawn sheets, for example, prior to subsequent welding previously had to be sent through a washing lane in order to prepare the surface of the aluminium sheets for the welding process. Said cleaning operation is now no longer necessary. As a result, aluminium-containing components having a coating may even without basic preliminary cleaning be reliably welded e.g. with a weld stud. The quality of the weld joint therefore depends on the ambient conditions in the joint zone which are created by the cleaning arc, wherein the surface is advantageously rendered dry and metallically pure.

It is advantageous when, after the first step of applying the cleaning voltage, in a second step a polarity of the first voltage is reversed. By said means the cleaning may be influenced by altering the arc. It is further advantageous when, after the first voltage used as a cleaning voltage has dropped, the actual lift-and-strike welding process ensues after a specific period of time. The process is improved by reversing the polarity between the first and subsequent second voltage. Said reversal is effected preferably in the period of time, during which the first voltage has dropped, in particular to zero. In said case, during the cleaning phase a positive polarity is preferably adjusted for the first voltage. This means that at the aluminium surface of the component there is a negative potential, while the weld-on element has a positive potential. It is therefore possible to heat the aluminium sheet up to temperatures at which the coating is volatilised. The aim is in particular to clean a region of the surface which, for example, approximately

corresponds to, or is optionally slightly smaller or slightly larger than, the subsequent joint zone. Given use of a weld stud, the aim is to achieve a circular cleaned surface having a diameter which preferably corresponds to the diameter of the weld stud. Given a different geometry of the weld-on component, e.g. an oval or angular cross section, the cleaned surface is advantageously of a corresponding sise. This is assisted by a polarity of the type described above. For the subsequent welding operation a negative polarity is preferably selected. A negative polarity during the cleaning operation might give rise to the problem of rust particles arising and/or remaining in the region of the surface to be cleaned.

The first voltage is moreover preferably set higher, in terms of its magnitude, than the immediately following voltage of reverse polarity. It is set, for example, by appropriate adjustment of the height to which the weld-on element is lifted above the surface. By increasing the distance, the voltage may likewise be increased while the current intensity, for example, remains constant. This enables a requisite energy density to be produced for the cleaning operation while, e.g. given use of a subsequent pilot current for the lift-and-strike welding process with reverse polarity, the aluminium surface is heated up and the arc stabilised in such a way that a weld pool of suitably required depth is produced when the subsequent welding voltage is applied.

The application of a first cleaning voltage may be effected separately from a subsequent application of a pilot welding voltage. For reversal of the polarity of the arc, it is advantageous when the polarity is reversed when the first voltage reaches a zero value. For said purpose, the zero value is advantageously maintained for a short time. Said voltage-free time is provided, for example, when the weld-on element is being moved in the direction of the surface. It is only after said time that a second voltage, e.g. a pilot voltage, is built up. For said purpose, the weld-on element is situated, after the cleaning operation, back in contact with the surface. By lifting the element off the surface, the welding arc e.g. in the form of a pilot arc is then ignited. Said machining steps are however preferably combined with one another. As a result, the machining time of a component is reduced. According to a development, said time reduction is achieved in that a drop of the first voltage is immediately followed by the welding process

preferably using a pilot voltage and subsequent welding voltage, wherein the last two voltages have a different polarity to the first voltage. In said manner, a reliable ignition of the arc after the polarity reversal is possible.

The possibility moreover exists of applying the welding voltage directly after the first voltage and the subsequent polarity reversal.

A second aluminium lift-and-strike welding process is further provided. Said process may, for example, be combined with the first aluminium lift-and-strike welding process. The second aluminium lift-and-strike welding process comprises the following steps:

- an electric cleaning current flows between an aluminium surface of a component and an element to be welded thereon, in that the component rests on the aluminium surface and then the element is lifted off the aluminium surface up to an approximately, in terms of time, constant distance for removing a coating from the aluminium surface through ignition of an arc as a cleaning agent,

- then the current changes its polarity, wherein afterwards at least one welding current is produced and

- then the element is welded to the aluminium surface.

The particular effect realised with said process is that during reversal of the polarity the current continues to flow between the surface and the element to such an extent that, despite the polarity reversal, the arc does not collapse. The element need not therefore be brought back into contact with the surface for ignition of the arc.

Preferably a cleaning current is used, which assumes a current intensity of between 15 and 120 amperes, in particular 500 amperes, before it drops. Said cleaning current intensity is sufficient for complete removal of the coating, which is situated e.g. on one aluminium surface, by means of the arc. In said case, the duration of the cleaning

operation may be influenced by the level of the current intensity: the higher the arc current, the shorter the duration of the cleaning operation. The cleaning current intensity is however preferably set low enough to prevent a weld pool area from starting to form on the aluminium surface. The temperature is taken into account in such a way that there is, in particular, not yet any melting of material during the cleaning operation. This is simultaneously regulated or controlled e.g. likewise by the duration of the effective cleaning current intensity. It has moreover proved advantageous when after a reversal of the polarity an, in terms of its magnitude, maximum current is produced. Said current is then the welding current which ensures the formation at the aluminium surface of a weld pool of corresponding molten material, into which the element to be connected, e.g. an aluminium stud with a melted end face, is subsequently dipped. Preferably, the element is brought back into contact with the aluminium surface only after disconnection of the welding current. In particular, such a time delay is observed, that the weld pool has become doughy again but nevertheless still retains its bonding capacity.

According to a development of the aluminium lift-and-strike welding process, the cleaning current lasts approximately as long as or longer, in particular at least 3 times longer, than a pilot current flowing prior to the welding current. It is further advantageous when the welding current is equal to or stronger, in particular at least 1.2 times stronger, than the cleaning current. The injection of power into the workpiece achieved in each case thereby is therefore appropriate to the respective objectives of the individual process steps. The maximum power injection is effected during the actual welding operation and a power injection for cleaning purposes, which is adapted to the respective coating of the aluminium surface, is accordingly lower.

The nature of the power injection may moreover also be regulated by means of the duration. This is dependent, on the one hand, upon the type of coating and, on the other hand, upon the thickness of the coating. In particular, the volatilising of the coating is recorded by a suitable apparatus and used as the basis for adjusting, e.g. regulating or controlling, a power injection by means of the cleaning current or the cleaning voltage. This also enables later evaluation of corresponding parameters of the cleaning operation for a subsequent quality inspection, e.g. while also taking into account parameters of the

subsequent welding operation. Volatilising of the coating is measurable, for example, through a variation of the arc voltage or the current. Through measurement of a suitable parameter, the duration of the cleaning step may also be regulated so that, given a corresponding variation of the measured value, e.g. of the voltage, the cleaning operation is terminated, the polarity is reversed and the welding process ensues. When, for example, the surface is being cleaned to remove an organic coating containing hydrogen, a voltage drop of the arc voltage is to be observed once the hydrogen, which is to be removed, has been removed. A corresponding lift-and-strike welding apparatus therefore comprises, for example, a suitable measuring, regulating and/or control device which provides appropriate functions. Such an apparatus also comprises a suitable evaluation device e.g. with a suitable memory etc.

It has further proved advantageous when the element, during cleaning of the aluminium surface, assumes a distance from the aluminium surface which is at least 2 times greater than the distance from the aluminium surface particularly when a pilot current flows prior to the welding current. It is therefore possible, on the one hand, to clean a larger area of the aluminium surface. On the other hand, the possibility exists of using a variation of the distance to adapt the intensity of the cleaning in accordance with the respective coating without having a negative effect upon the base material.

Besides the previously described features, the measures for controlling and/or regulating the weld stud which are known from DE 195 244 90 are moreover also applicable for effecting the aluminium lift-and-strike welding process. In particular, it has proved advantageous to use, for welding-on, stud geometries of the type disclosed in DE 196 11 711. Express reference is hereby made to the respective technical teaching of both documents.

An aluminium lift-and-strike welding apparatus is further provided. The apparatus comprises a guide for a weld-on element and a control device for the guide. The guide is, for example, a welding head, a welding gun or a housing for fixing and lifting the weld-on element. The apparatus further comprises a device for controlling or regulating the electric current and/or the voltage used for welding, wherein the apparatus has a polarity

reversing means for the voltage used for welding. The device for controlling or regulating the electric current and/or the voltage is programmed or designed so as to produce, prior to the welding operation, a cleaning current which has a reverse polarity relative to the welding current. The apparatus may be used in particular to effect a process in accordance with the above description.

The invention further provides a polarity reversing means for a lift-and-strike welding apparatus, The polarity reversing means comprises a circuit element which produces an arc current during the reversal of the polarity, in particular in the form of a circuit acting as a reactor in order to maintain a struck arc during a reversal of the polarity of the arc voltage. The polarity reversing means advantageously comprises a first and a second power source, wherein the first power source supplies a cleaning current and the second power source supplies a welding current. A coil is advantageously connected to the first and the second power source in such a way that a struck arc continues to be maintained during reversal of the polarity. An extinction of the arc is therefore prevented when the current passes through zero.

Further advantageous refinements and developments as well as features of the invention are illustrated in greater detail in the following drawings, in which:

Fig. 1 shows a characteristic of a distance S and of an electric cleaning current I in a first step of the lift-and-strike welding process,

Fig. 2 shows the characteristic of the distance S and of the electric current I in a welding step as a third step of the process,

Fig. 3 shows a development in the form of a combination of the first step, a second step and the third step,

Fig. 4 shows an apparatus for implementing the process,

Fig. 5 shows a sketch of the apparatus for implementing the process,

Fig. 6 shows a circuit diagram of a polarity reversing means and

Fig. 7 shows a stud welded on a sheet having a coating.

Fig. 1 is a diagram illustrating a possible first step as a cleaning step of the process sequence of the welding process. A current intensity I and a distance S are plotted along the y-axis. The distance S is the distance between the weld-on element and an exemplary aluminium surface. The time coordinate is plotted along the x-axis. In the first step, the weld-on element is situated in contact with the aluminium surface. The current intensity I is switched on. A flow of current occurs between aluminium surface and the element. The cleaning current being injected is preferably adjusted to a magnitude of between 20 and 500 amperes. Said cleaning intensity is preferably held approximately constant also for a specific period of time. After a short time delay after switching on the current intensity I, the element is lifted off the aluminium surface and preferably moved up to an approximately constant distance S. The cleaning current intensity is kept constant and the arc voltage arises in accordance with the distance S and the degree of cleaning. The distance S is advantageously approximately 3 mm for an aluminium weld stud. After a duration Δt, which starts with lifting of the element from the aluminium surface and ends with the dropping of the cleaning current intensity to zero ampere, the aluminium surface is cleaned. The duration Δt is preferably set between 15 ms and 120 ms. The advantage of said cleaning is that the cleaned area remains limited at least to approximately the weld pool area subsequently required. When, for example, there is provided on the aluminium surface a coating which is to be retained also in the subsequent workpiece, e.g. a protective coating, the process offers the advantage of having removed the coating only in the region of the welding zone. The distance S is in particular adjusted in such a way that the arc which arises is focused on the aluminium surface and so the surface to be cleaned remains limited. Preferably, such a focusing of the arc is adjusted by means of a suitable guide for the weld-on element. Alternatively, the welding apparatus may have a suitable focusing device which is, for example, integrated with the guide. According to one construction of a suitable welding apparatus, use is made for said purpose of a guide comprising a collet, around which an a.c.-operated magnet coil is

disposed. By said means it is possible to prevent a dispersion of the arc as a result of blowout. The first step is followed by the polarity reversal as a second step, which is not shown in detail.

Fig. 2 shows a third step of the process which comes after the first step of Fig. 1 and the second step, namely the subsequent polarity reversal. The polarity reversal is evident from the change of the sign of the current intensity. Preferably, a change from positive to negative occurs. According to a development, the weld-on element remains in the lifted position, e.g. 3 mm up, for a specific period of time. This allows any material of the aluminium surface and also possibly of the surface of the element itself which has already melted to harden again. For example, 10 to 80 ms, preferably up to 30 ms after disconnection of the current intensity, the lift e.g. by means of a coil is switched off and the element comes back into contact with the aluminium surface. From said point on, the third step in Fig. 2 begins. Reversal of the polarity from positive to negative in the second step is followed by the start of a lift-and-strike welding process of the type disclosed e.g. also by the already cited DE 195 244 90. For example, an arc is ignited by a pilot current, which provides for a stabilising of the welding current. For said purpose the weld-on element, which has been back in contact with the aluminium surface, is removed once more from the surface. According to the diagrammatic embodiment, the distance S then remains once more substantially constant. After a specific period, which lasts longer than the actual welding current duration, the pilot current is increased to a welding current, e.g. to 1000 amperes or more. During application of the welding current, the aluminium surface is melted to such an extent that an adequate pool depth is provided. After the welding current has dropped to 0 ampere, there is additionally a specific waiting period to allow the aluminium pool to become doughy. Only then is the element to be welded dipped into the surface and the weld joint produced. An implementation of the process in the manner shown in Fig. 1 and Fig. 2 has the advantage of a precisely predetermined pattern. By linking the steps to one another, the machining time is simply added up. This may lead to somewhat longer retention times in the machining station, e.g. of 300 ms and more. Said time is also dependent *inter alia* upon how much time the reversal of the polarity takes. The reversal preferably takes no longer than 200 ms. A development therefore provides that the first step of Fig. 1 and the

third step of Fig. 2 be combined with one another. This is explained in greater detail below.

Fig. 3 shows a combination of the first, second and third steps of Fig. 1 and Fig. 2 in the form of a combination of the process steps without contact of the weld-on element between cleaning and welding. A reversal of the polarity of the current is effected without the weld-on element in the meantime coming into contact with the aluminium surface. Rather, the cleaning current I is converted by reversal of the polarity into a pilot current of the welding process. Said reversal is effected by suitable adaptation of the decrease of the cleaning current intensity up to the passage through zero. After the passage through zero, the current intensity with a negative polarity, indicated by the minus sign in Fig. 3, is controlled or adjusted to a suitable current magnitude of a pilot current. Then the maximum welding current ensues. Compared to the individual steps as they emerge from Fig. 1 and Fig. 2, the machining time is only an insignificant amount, e.g. about 100 ms, longer than a conventional lift-and-strike welding process.

Tests have shown that, with the following values, particularly good welding results have been achieved for an aluminium surface in combination with an aluminium stud:

cleaning current intensity:	15-500 amperes
cleaning period:	20-100 ms
distance S for duration of cleaning	2.5-3.5 mm
pilot current intensity:	15-25 amperes
duration of pilot current intensity:	0-8 ms
distance S for duration of pilot current:	0.6-1.4 mm
welding current intensity:	500-1500 amperes
duration of welding current:	8-100 ms
distance S for duration of welding current:	1.4 down to 0.6 mm

Fig. 4 shows the diagrammatic view of an apparatus 1 for implementing the lift-and-strike welding process. The apparatus 1 comprises a collet 2, around which a coil 3 is disposed. By means of the collet 2 a weld-on element 4, in the present case an

aluminium weld stud, is guided onto an aluminium surface 5 of an aluminium sheet 6. During the welding operation an inert gas, e.g. argon, flows around the element 4. The inert gas is indicated by the arrows 7 which surround the element 4. Alternating current flows through the coil 3. The alternating current is controlled and/or regulated so that it influences the arc and the arc shape in such a way that the coating 8 on the aluminium surface 5 is removed only in the region where a welding with the element 4 also later occurs. The coil 3 is preferably operated with an alternating current of between 8 and 30 volts. A current intensity of between 0.1 and 2 amperes is advantageously used. The number of turns as well as the cross section of the coil turn are material-dependent. The coil is in particular selected so as to be capable of bringing the arc very close in to the axial magnetic field and not into the stray field. The stray field would produce a rotating arc, while the axial magnetic field is capable of focusing the arc symmetrically around the axial axis of the stud.

Fig. 5 shows a diagrammatic view of the lift-and-strike welding apparatus. By means of a guide 9 a weld-on element (not shown in detail) may be guided onto an aluminium component (not shown). The apparatus further comprises a control device 10 or regulator for the guide 9. The apparatus 1 likewise comprises a device 11 for controlling or regulating the electric current and/or the voltage used for welding as well as a polarity reversing means 12 constructed e.g. by means of thyristors. The device 11 is programmed or operated in such a way as to produce, prior to a welding operation, a cleaning current which has a reverse polarity compared to the welding current. The reversal of the polarity is effected by means of the polarity reversing means 12. The lift-and-strike welding apparatus 1 may be used in particular to produce an aluminium surface with a welded-on element, wherein the aluminium surface has or has had a coating, in particular a lubricant coating.

Fig. 6 shows an exemplary circuit diagram of a polarity reversing means 12. A first 13 and a second 14 power source are connected in parallel. Both power sources 13, 14 here are constant-current sources. The first power source 13 supplies a current for cleaning and builds up a positive polarity: whereas the stud has a positive potential, the sheet 6 has a negative potential. This is indicated by the plus sign. The second power

source 14 supplies a current for the welding step and hence for the pilot current and the actual welding current. The second power source 14 comprises a shorted circuit, which is activated by a closed switch S2. When the polarity reversal is initiated, the second power source 14 operates in the short circuit and injects a current into a reactor 15. The cleaning current produced by the first power source 13 is then reduced towards zero. Before the cleaning current reaches zero, the shorted circuit switch S2 is opened and the welding circuit switch S1 is closed. The injected current in reactor 15 flows into the welding circuit. It prevents extinction of the arc when the current passes through zero. The switch S3 is opened and the first power source 13 is decoupled from the welding circuit.

Fig. 7, in a view corresponding to Fig. 4, shows a stud 4 now welded on a sheet 6 having a coating 8 on the surface. In the region of a joint zone 16 the coating 8 is no longer provided. It has been removed during the cleaning step in the region of connection of the stud 4 and the sheet 6 in accordance with the adjustment of the arc. The process is therefore also particularly suitable for producing a steel sheet with a welded-on element, wherein the steel sheet surface has or has had a coating, in particular a lubricant layer or a zinc layer.

CLAIMS

1. First lift-and-strike welding process, wherein in a first step a surface (5) of a component is cleaned by applying a first voltage so as to strike an arc between an element (4), in particular a stud, which is to be connected to the surface (5), and the surface (5), in a second step a polarity of the first voltage is reversed and wherein the element (4) is then welded on by means of at least one arc struck by means of a second voltage.

2. Lift-and-strike welding process according to claim 1, wherein the first voltage is set, in terms of its magnitude, higher than a subsequent second voltage of reverse polarity.

3. Lift-and-strike welding process according to claim 1 or 2, wherein the first voltage is adjusted with a positive polarity.

4. Lift-and-strike welding process according to one of claims 1 to 3, wherein the element is welded onto the component after the component has previously been covered with a coating, in particular a lubricant layer for a cold-forming machining operation, preferably a deep-drawing machining operation.

5. Lift-and-strike welding process according to one of claims 1 to 4, wherein after a drop of the first voltage a polarity of the first voltage changes in a zero-current state, a welding process using preferably a pilot voltage and subsequent welding voltage then ensues, wherein both voltages have a different polarity to the first voltage.

6. Lift-and-strike welding process according to one of claims 1 to 5, wherein upon attainment of a passage through zero of the first voltage a zero voltage is maintained for a time, after which a second voltage is built up.

7. Second lift-and-strike welding process, in particular according to one of claims 1 to 6, wherein

- an electric cleaning current flows between a surface (5) of a component and an element to be welded thereon, in that the component rests on the surface (5) and then the element (4) is lifted off the surface (5) up to an approximately, in terms of time, constant distance for removing a coating from the surface (5) through ignition of an arc as a cleaning agent,

- then the current changes its polarity, wherein afterwards at least one welding current is produced and

- then the element (4) is welded to the surface (5).

8. Lift-and-strike welding process according to one of claims 1 to 7, wherein the cleaning current assumes a current intensity of between 15 amperes and 500 amperes before it drops.

9. Lift-and-strike welding process according to claim 7 or 8, wherein after a reversal of the polarity an, in terms of magnitude, maximum welding current is produced.

10. Lift-and-strike welding process according to one of claims 1 to 9, wherein the element (4) is brought back into contact with the surface (5) only after disconnection of the welding current.

11. Lift-and-strike welding process according to one of claims 1 to 10, wherein the cleaning current lasts as long as or longer than a pilot current, which flows prior to the welding current, and/or the welding current.

12. Lift-and-strike welding process according to one of claims 1 to 11, wherein the welding current is equal to or stronger than the cleaning current.

13. Lift-and-strike welding process according to one of claims 1 to 12, wherein the element (4) during cleaning of the surface (5) assumes a distance (S) from the surface (5)

which is at least two times greater than the distance (S) from the surface (5) during welding, in particular when a pilot current flows prior to the welding current.

14. Lift-and-strike welding process according to one of claims 1 to 13, wherein through the measurement of a parameter a duration of the cleaning step is regulated or controlled.

15. Lift-and-strike welding apparatus (1) having a guide (9) for a weld-on element (4) and a control device (10) or regulator for the guide (9) as well as a device (11) for controlling or regulating the electric current and/or the voltage used for welding, wherein the lift-and-strike welding apparatus (1) comprises a polarity reversing means (12) for the voltage used for welding, characterised in that the device (11) for controlling or regulating the electric current and/or the voltage used for welding is programmed or operated in such a way as to produce, prior to the welding operation, a cleaning current which has a reverse polarity compared to the welding current.

16. Lift-and-strike welding apparatus (1) according to claim 15, characterised in that said apparatus is designed for implementing a process according to claims 1 to 14.

17. Lift-and-strike welding apparatus (1) according to one of claims 15 or 16, characterised in that said apparatus comprises a focusing device for an arc which is to be struck.

18. Lift-and-strike welding apparatus (1) according to one of claims 15 to 17, characterised in that the polarity reversing means (12) comprises a shorted circuit for maintaining a struck arc during a reversal of the polarity.

19. Lift-and-strike welding apparatus (1) according to one of claims 15 to 18, characterised in that said apparatus comprises an evaluation device, particularly for quality inspection, for at least one parameter at least of the cleaning operation.

20. Polarity reversing means (12) for a lift-and-strike welding apparatus in particular according to one of claims 15 to 19, characterised in that the polarity reversing means (12) comprises a circuit element, which produces an arc current in order to maintain a struck arc during a reversal of a polarity of the arc voltage.

21. Polarity reversing means (12) according to claim 20, characterised in that the polarity reversing means (12) comprises a first (13) and a second (14) power source, wherein the first power source (13) supplies a cleaning current and the second power source (14) supplies a pilot current and/or a welding current.

22. Polarity reversing means (12) according to claim 20 or 21, characterised in that a coil (15) is connected to the second power source (14) in such a way that a struck arc continues to be maintained during a reversal of the polarity.

23. Aluminium surface with welded-on element (4), wherein the aluminium surface (5) has or has had a coating (8), in particular a lubricant layer, manufactured using a process according to one of clams 1 to 14.

24. Steel sheet with welded-on element, wherein the steel sheet surface has or has had a coating, in particular a lubricant layer or a zinc layer, manufactured using a process according to claims 1 to 14.

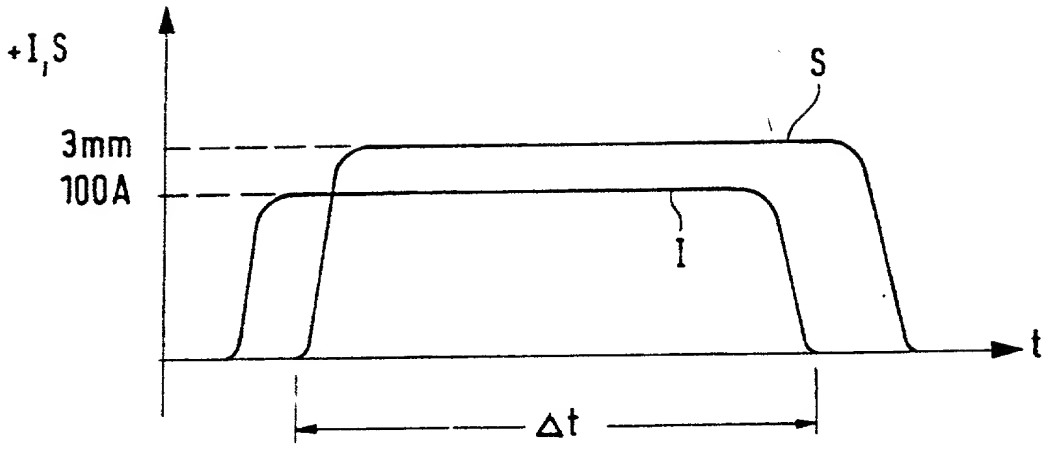


FIG.1

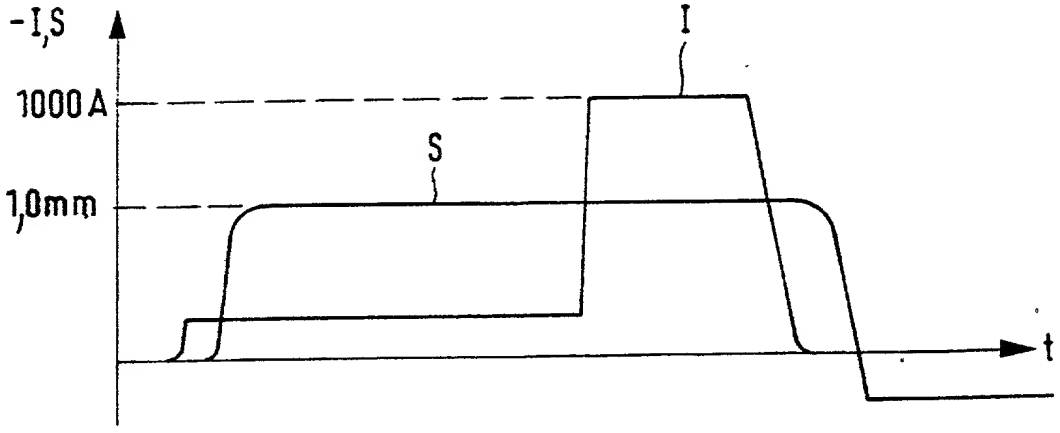


FIG.2

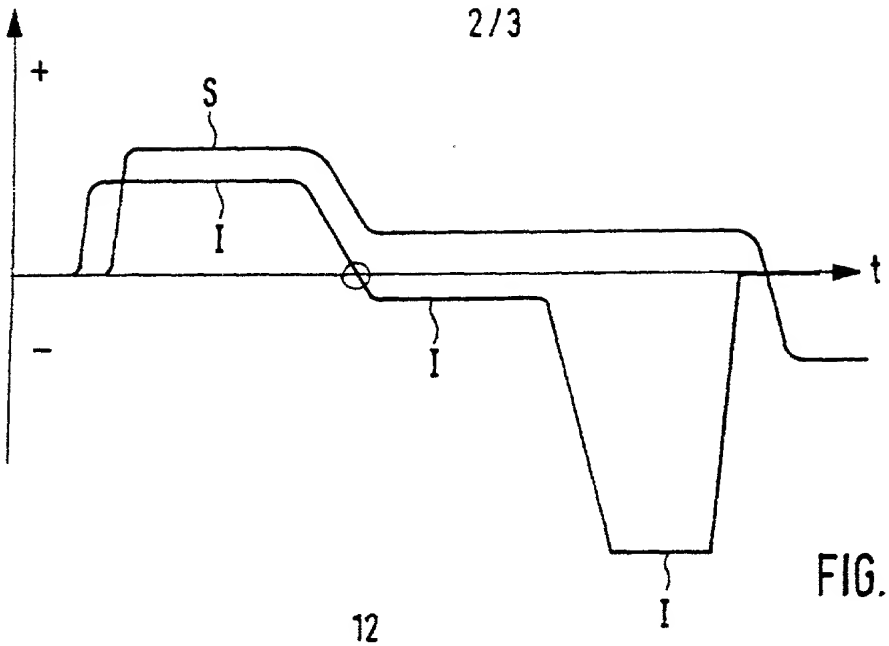


FIG.3

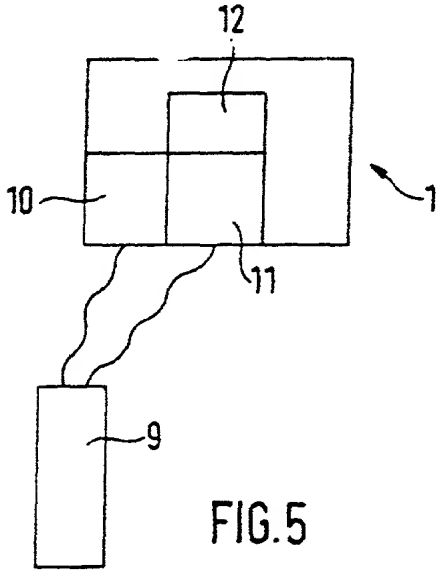


FIG.5

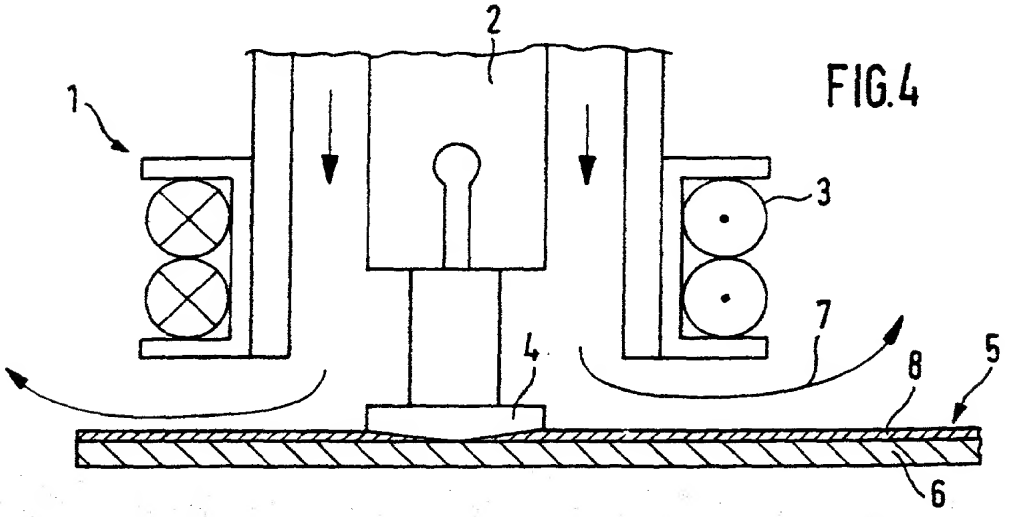


FIG.4

FIG.6

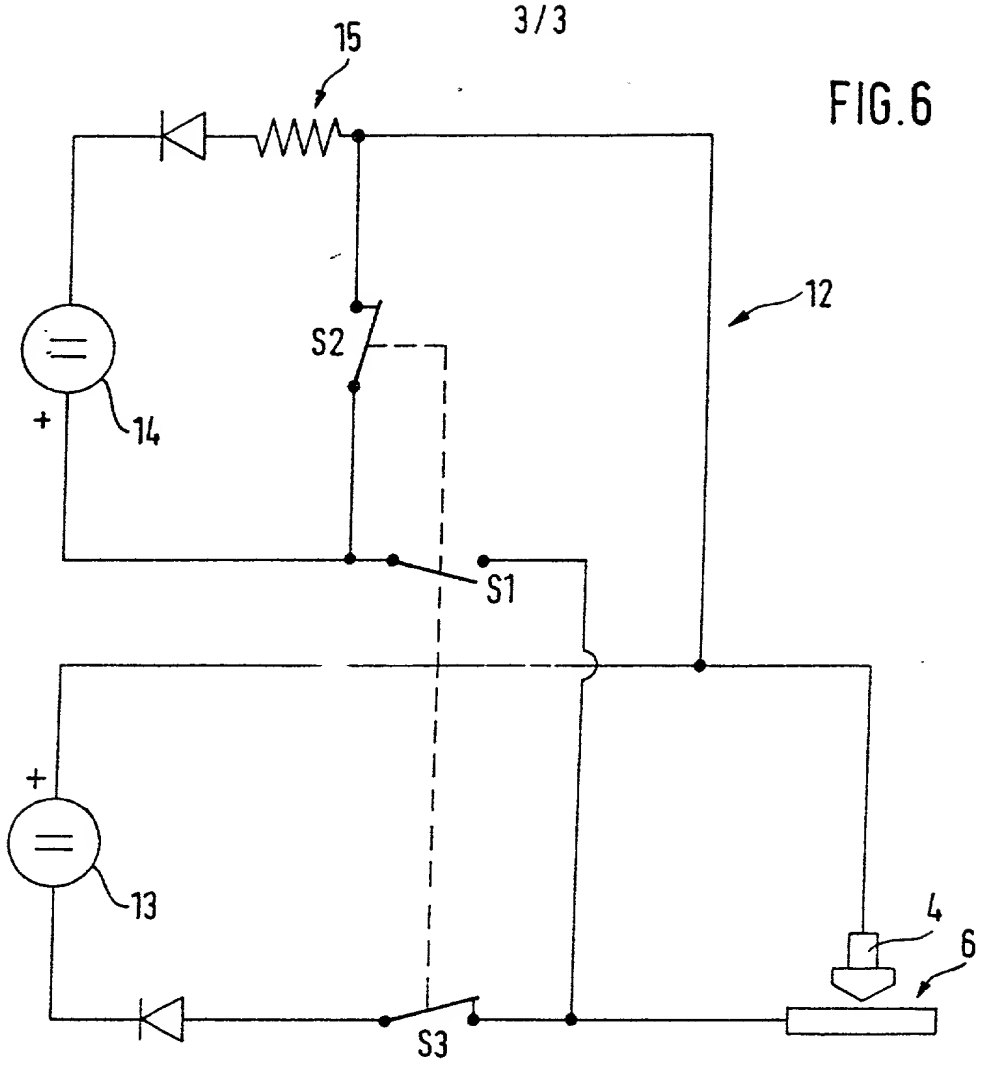
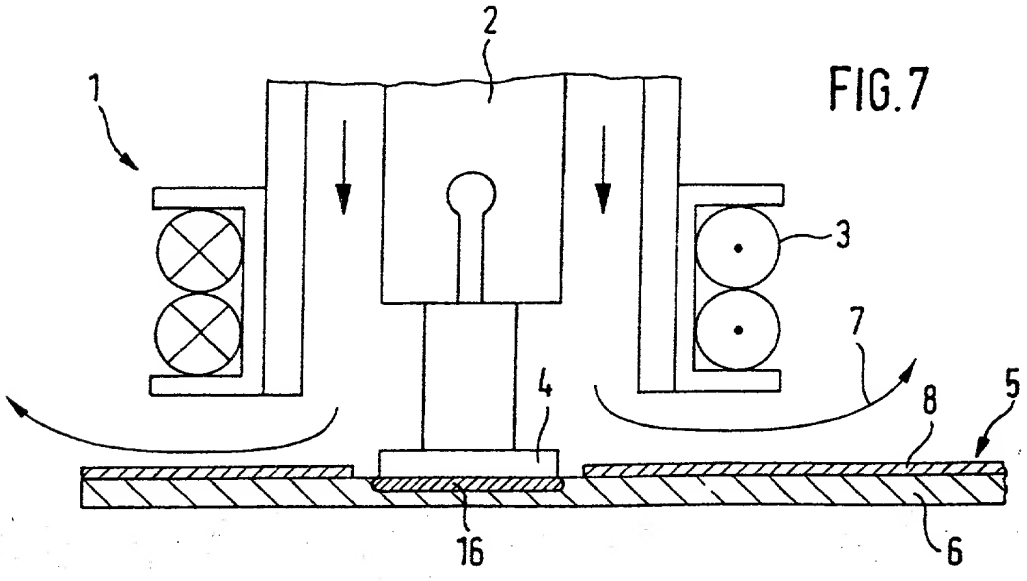


FIG.7



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DECLARATION — Utility or Design Patent Application

Direct all correspondence to: ☐ Customer Number or Bar Code Label [ ] OR [X] Correspondence address below

Name: Edward D. Murphy, Esq.

Address: The Black & Decker Corp.
701 East Joppa Road

City: Towson | State: MD | ZIP: 21286

Country: U.S.A. | Telephone: (410) 716-2867 | Fax: 410-716-2610

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR : ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any]): Michael | Family Name or Surname: KRENGEL

Inventor's Signature: Michael Krengel | Date: 11.12.01

Residence: City: Giessen DE | State: | Country: Germany | Citizenship: German

Mailing Address: Giessner Strasse 123

City: Giessen | State: | ZIP: D-35396 | Country: Germany

NAME OF SECOND INVENTOR: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any]): Haymo | Family Name or Surname: GOTTWALS

Inventor's Signature: Haymo Gottwals | Date: 11.12.2001

Residence: City: Muecke DE | State: | Country: Germany | Citizenship: German

Mailing Address: Hermannsbergweg 6

City: Muecke | State: | ZIP: D-35325 | Country: Germany

[X] Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.

Please type a plus sign (+) inside this box → ✱

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 1 of 1

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])	Family Name or Surname		
Klaus Gisbert	SCHMIDT		
Inventor's Signature Klaus J. Schmidt		**Date** 19-12-01	
Residence: City Giessen DEX	**State**	**Country** Germany	**Citizenship** German
Mailing Address Alicenstrasse 22			
Mailing Address			
City Giessen	**State**	**ZIP** D-35390	**Country** Germany

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])	Family Name or Surname		
Reinhold	BROEHL		
Inventor's Signature R. Broehl		**Date** 19.12.01	
Residence: City Staufenberg	**State** DEX	**Country** Germany	**Citizenship** German
Mailing Address Daubringer Strasse 7			
Mailing Address			
City Staufenberg	**State**	**ZIP** D-35460	**Country** Germany

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any])	Family Name or Surname		
Wolfgang	SCHMIDT		
Inventor's Signature W. Schmidt		**Date** 15.12.01	
Residence: City Reiskirchen	**State** DEX	**Country** Germany	**Citizenship** German
Mailing Address Kopernikusweg 5			
Mailing Address			
City Reiskirchen	**State**	**ZIP** D-35447	**Country** Germany

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing **OR** ☑ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	GER5355
First Named Inventor	KRENGEL
COMPLETE IF KNOWN	
Application Number	09 / 980,169
Filing Date	11/29/2001
Art Unit	
Examiner Name	

As the below named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name.

I believe I am the original and first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

LIFT-AND-STRIKE WELDING PROCESS WITH CLEANING STAGE

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 05/05/2000 as United States Application Number or PCT International

Application Number GB00/01727 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	Certified Copy Attached? NO
199 25 628.4	Germany	06/05/1999	☐	☐	☒
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto: